

# How Igalia is Driving Innovation in Embedded Systems with Open Source Technologies

Manuel Rego & Mario Sánchez-Prada

Embedded Open Source Summit 2023

# About us



Manuel Rego

[rego@igalia.com](mailto:rego@igalia.com)



Mario Sánchez-Prada

[mario@igalia.com](mailto:mario@igalia.com)



# igalia

Open Source Consultancy

# About Igalia

- Highly specialized **Open Source consultancy** founded in 2001
- **Worker-owned, employee-run, flat structure** (140+ igalians)
- **Top contributors to Chromium, WebKit and Gecko**
- **Active contributor to other OSS projects**
  - V8, SpiderMonkey, JSC, LLVM, Node.js, GStreamer, Mesa, Linux Kernel...
- **Members of several working groups:**
  - W3C, WHATWG, WPT, TC39, OpenJS, Test262, Khronos...

# Embedded devices

- **Web UIs** are used for a wide range of different use cases
- **GStreamer** often used for multimedia (e.g. HW-accel, MSE, EME)
- **Wayland and DRM/KMS** widely used in embedded devices
- Good **graphics drivers** crucial to optimal performance
- **Linux** as the most widely used OS in embedded devices
- **Virtual** and **Augmented** reality

# Igalia and embedded devices

- Smart TVs, set-top-boxes and video game consoles
- Smart home appliances and home automation devices
- Hi-Fi audio systems and video editing devices
- In-vehicle and in-flight infotainment systems
- Navigational and GPS-based instrumentation
- Virtual and Augmented reality headsets
- Digital signage

# Web Rendering Engines



**servo**

# WPE WebKit





# WPE WebKit

- **WebKit: OSS Web rendering engine** for desktop & embedded
- **WPE: WebKit port for embedded devices**
  - Focus on flexibility, security and performance on lower-powered devices
  - Great for **HW-based acceleration** and specific integration requirements
  - **Widely used for multimedia** (i.e. MSE, EME, WebRTC, WebAudio...)
  - Also useful for **other use cases** e.g. **server-side, headless** Web rendering...

<https://wpewebkit.org/>

# Igalia and WebKit

- **Second committer to WebKit project** after Apple
  - **15+ years** of contributions. 22 reviewers, 44 committers
- **Lead developers** of the two only Linux-based **WebKit *ports***
  - WebKitGTK and WPE (started from scratch in 2014)
- **Implementation of Web standards** and **JavaScript features**
- **GStreamer-based multimedia stack** in WebKitGTK and WPE
- **Accessibility support** on Linux
- **Other:** 32-bit systems, performance, bugfixing, QA...

# Igalia, WPE WebKit and embedded

- **Development and maintenance of WPE for RDK set-top-boxes**
- **New HW-accelerated SVG engine** in WebKit
- **Integration of WPE's GStreamer backends with DRM systems**
- **Custom WPE backends** for specific Hardware
- **Experiments** about supporting **WPE on Android** devices
- **Maintenance of downstream forks** for customers



# Chromium



# Chromium

- Standalone **Open Source Web browser** (not just the engine)
- Available for **different platforms**, desktop & mobile
  - Windows, Mac OS, Linux, Android and iOS
- Used as the **base of several browsers** and **apps**:
  - e.g. Chrome & ChromeOS, Edge, Opera, Samsung Browser, CEF, Electron...
- Also used on **embedded devices** for certain use cases
  - e.g. Automotive Grade Linux (AGL)

<https://chromium.org/>

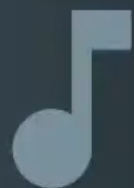
# Igalia and Chromium

- **Second committer to Chromium project** after Google
  - **10+ years** of contributions. 14 owners, 25 committers
- **Lead developers of native Wayland support**
- **Implementation of Web standards and JavaScript features**
- **Accessibility support**
- **Other:** performance, bugfixing, refactoring, code health...

# Igalia, Chromium and embedded

- **Ported Chromium to specific hardware platforms**
- Deployment of Chromium-based **Web runtimes** (e.g. WebOS)
- **Active members** of the **Automotive Grade Linux project**
- **Maintenance of downstream forks** for customers

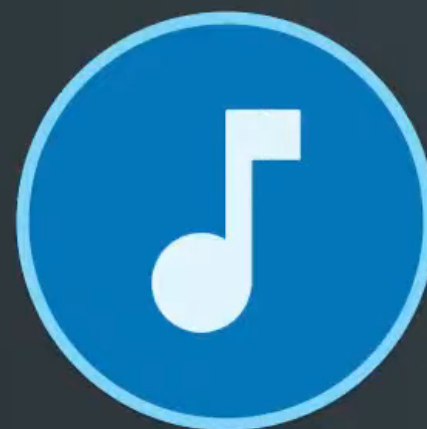




DASHBOARD



HVAC



MEDIA

Thursday

7 PM

**servo**

# Servo

- **Independent, modular, embeddable Web rendering engine**
- Focus on **speed, security**, API for **embedders** and **cross-platform support** (currently on Windows, Mac, Linux)
- Written in **Rust**: memory safety, concurrency

<https://servo.org/>

# Igalia and Servo

- **R&D effort started in 2012** (Mozilla Research)
  - Initial participation from **Igalia from 2014 to 2020**.
- **Servo moved** from Mozilla Research to the **LF in 2020**
  - Original mission remained unchanged
- **Igalia took over Servo maintenance in 2023**
- **2023 roadmap**: upgrade main dependencies, CSS2 conformance, embeddable Web engine experiments, Android

# Igalia, Servo and embedded

- Embedded devices that need a **small, fast and secure Web view**
- Simple embedded Web applications (**controlled environment**)
- **Advanced Web features** like WebGL, WebGPU, WebXR...
- **Use cases:** kiosk mode applications, UI frameworks...

# Multimedia & Graphics



# GStreamer

- **Reference framework** for Linux-based multimedia
- **Flexible architecture design** i.e. pipelines & plugins
- Multiple **use cases**: media players, Web browsers, video editors, transcoders, streaming services, server-side rendering...



# Igalia and GStreamer

- **Top consultancy company** with GStreamer in **Web engines**
  - Second contributor to GStreamer in the past 5 years
- **15+ years** of contributions to GStreamer. 9 contributors
  - Strong experience in **multimedia in embedded devices**
- Lead development of **GStreamer-based back-ends** of **WebKit**:
  - Video playback, WebAudio, WebRTC, adaptive streaming, MSE, EME...
- **GStreamer-VA, Vulkan elements**: HW-accelerated plugins
  - Video encoding, decoding, post-processing and rendering plugins
- **GStreamer Editing Services, Pitivi**: API for nonlinear video editing, OpenTimelineIO-compatible video editor

# Igalia, GStreamer and embedded

- **New GStreamer features** developed upstream (core & pugins)
  - Enable key features crucial for the embedded industry
- **GStreamer-based back-ends** in different **Web rendering engines**
  - Direct impact in millions of embedded devices (e.g. set-top-boxes)
- **Improving performance** by providing **HW acceleration solutions**
  - Key for constrained and lower-powered devices
- Integration with **different multimedia libraries**
  - Adapt and develop GStreamer pipelines tailored to specific HW



# Mesa

- **Mesa:**
  - Open Source implementation (library) of OpenGL and Vulkan
  - Includes graphics drivers for different GPU vendors
- **OpenGL and Vulkan:**
  - Cross-platform APIs to expose GPU HW to application programmers
  - Developed by the Khronos group

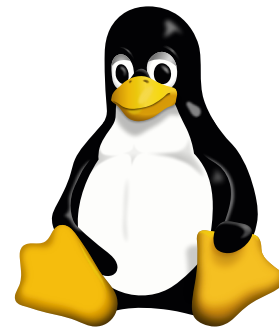
# Igalia and Mesa

- **9+ years** of contributions to the Mesa project
- **Development and maintenance of Mesa drivers** for OpenGL and Vulkan aimed at **different GPU hardware platforms**
- **Conformance Tests Suites (CTS):** OpenGL and Vulkan
  - Work to expand API coverage to become conformant with different versions

# Igalia, Mesa and embedded

- **OpenGL & Vulkan drivers development** for different GPUs
  - e.g Raspberry Pi, Qualcomm Adreno, Vivante
- Developed a **Vulkan driver for Raspberry Pi 4**
  - Started on January 2020, Vulkan 1.2 conformant
- **HW-accelerated encoding/decoding support**
  - Optimization of graphics pipelines
- **Integration** with the underlying **graphical systems**
  - e.g. Wayland, DRM/KMS

# Operating systems



# Operating systems

- The **Linux Kernel**:
  - Low-level abstraction layers
  - Exposes I/O devices
  - Processes & memory management, filesystems, CPU schedulers, drivers...
  - **Most common kernel used in embedded devices**
- Other components:
  - Windowing systems, drivers, desktop integration, i18n/l10n, sandboxing...



# Igalia and Linux-based OS's

- **10+ years** in the lower layers of the kernel
- **20+ years** of experience as Debian developers
  - Maintenance of the **RISC-V** Debian port
- **Maintainers of the VKMS** (virtual display i.e. for headless use)
- **Contributors to Linux kernel** drivers for different GPUs:
  - VideoCore (vc4, c3d), AMD (amdgpu), Vivante (etnaviv)
- **Other**: distros customization, power management, filesystems (btrfs), kdump/kexec, udisks, futex2, flatpak, graphical toolkits...

# Igalia, Linux and embedded

- **Build systems, tools and frameworks:** Yocto, Buildroot...
- **Linux device drivers:** networking, graphics...
- **Creation** of Linux distributions and/or filesystems
- Adaptation aimed at **specific hardware requirements**
- **Porting software** to **custom embedded OS's**

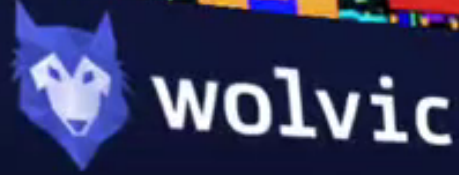
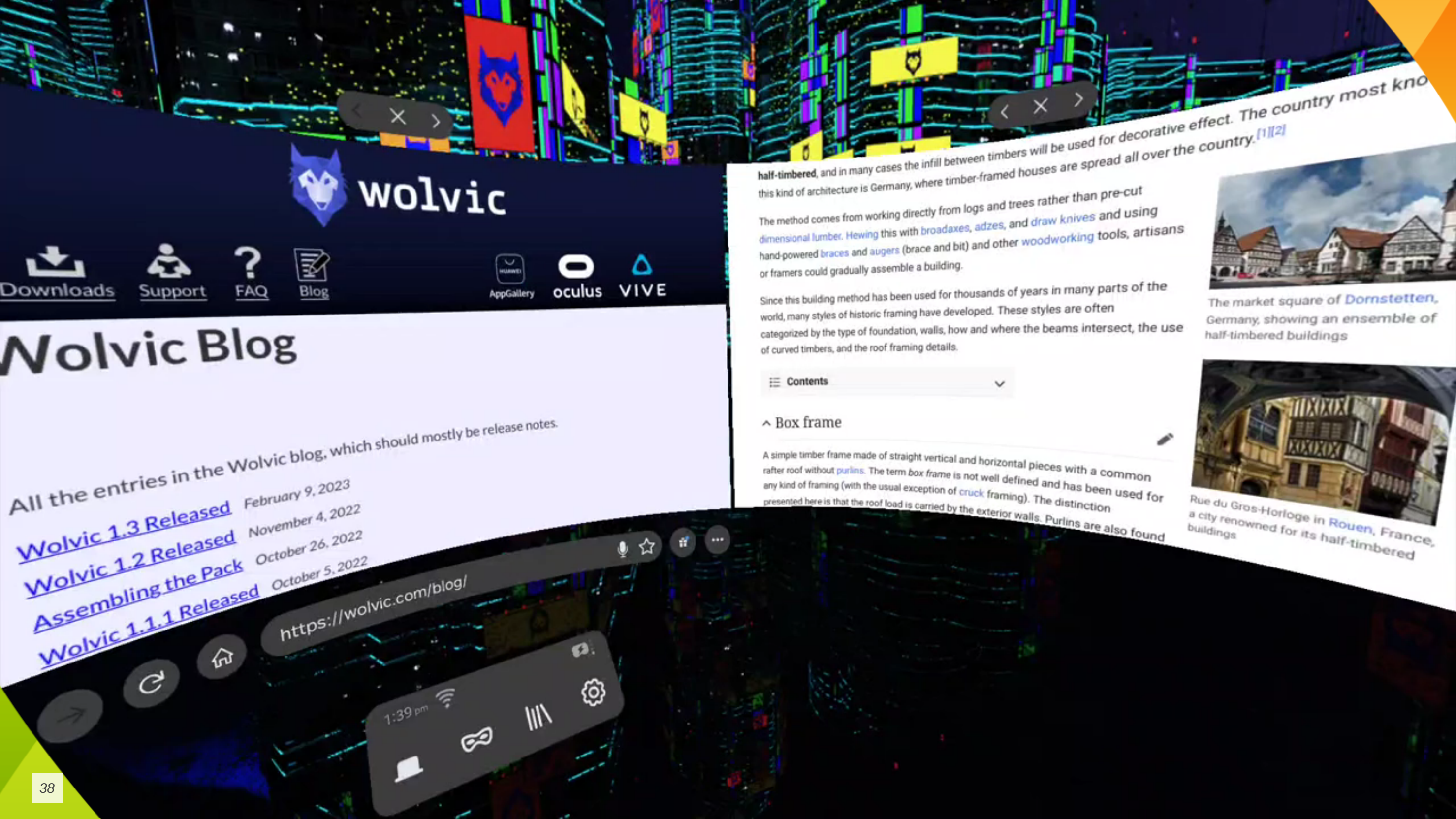
# Virtual & Augmented Reality






# Wolvic

- **Open Source Web browser for Virtual Reality**
  - Supports immersive experiences
- **Started by Mozilla** as Firefox Reality in 2018, currently being **developed and maintained by Igalia since 2022**
- **Available** in several **app stores from VR devices**:
  - Huawei app gallery, Meta Quest app store, Pico XR app store
- **Support for a growing range of devices**:
  - Meta Quest2 and Meta Quest Pro, Huawei VR Glasses, Pico4 and Pico4E, Qualcomm Snapdragon Spaces...

<https://wolvic.com>



-  Downloads
-  Support
-  FAQ
-  Blog
-  AppGallery
-  oculus
-  VIVE

# Wolvic Blog

All the entries in the Wolvic blog, which should mostly be release notes.

- [Wolvic 1.3 Released](#) February 9, 2023
- [Wolvic 1.2 Released](#) November 4, 2022
- [Assembling the Pack](#) October 26, 2022
- [Wolvic 1.1.1 Released](#) October 5, 2022

<https://wolvic.com/blog/>

half-timbered, and in many cases the infill between timbers will be used for decorative effect. The country most known for this kind of architecture is Germany, where timber-framed houses are spread all over the country.<sup>[1][2]</sup>

The method comes from working directly from logs and trees rather than pre-cut dimensional lumber. Hewing this with broadaxes, adzes, and draw knives and using hand-powered braces and augers (brace and bit) and other woodworking tools, artisans or framers could gradually assemble a building.

Since this building method has been used for thousands of years in many parts of the world, many styles of historic framing have developed. These styles are often categorized by the type of foundation, walls, how and where the beams intersect, the use of curved timbers, and the roof framing details.

## Contents

### Box frame

A simple timber frame made of straight vertical and horizontal pieces with a common rafter roof without purlins. The term box frame is not well defined and has been used for any kind of framing (with the usual exception of cruck framing). The distinction presented here is that the roof load is carried by the exterior walls. Purlins are also found



The market square of [Dornstetten](#), Germany, showing an ensemble of half-timbered buildings



Rue du Gros-Horloge in [Rouen](#), France, a city renowned for its half-timbered buildings

# **Vision of embedded devices and technologies**



# Open Source

- **Embedded systems** are attached to **Open Source**
- **High impact projects** are basic assets in the embedding industry
- **Major organizations** are contributing upstream to these projects



# Web Platform

- **Web engines are extremely relevant** for embedded devices
  - They are **not just for Web browsers**
  - **Web-based UIs** are getting more popular
- The **Web is an openly developed platform**
  - Under **continuous evolution**
  - Alternatives can bring **diversity to the Web platform ecosystem**

# Highly specialized expertise

- **Embedded devices** have a different set of requirements and needs
- Development of **new features** targeted for embedded systems
- **Performance optimizations** across all the layers of the stack

# Wrap up

- **Explosion** of interconnected smart devices
- **Lower-powered and constrained devices**
- **Reduce carbon footprint**, focus on extending life of devices

**Tension** between **product features**, **hardware capabilities** and **power consumption**  
(i.e. "more with less")

# Thanks

